Appendix D

Low Flow Pilot Study

D.1 INTRODUCTION

The purpose of the Low Flow Pilot Study was to assess feasibility of modifying the sampling equipment at land use stations to monitor storms as small as 0.1 inches of rainfall. Currently the land use monitoring equipment is designed to monitor storms greater than 0.25 inches of rainfall. To conduct the assessment the equipment at a single land use monitoring station was modified to capture events as small as 0.1 inches. The feasibility assessment was based on the following criteria:

- the operational effectiveness of the sampler at low storm volumes;
- the feasibility and effectiveness of sample retrieval and transport; and
- the ability to reprogram and maintain this setting at other samplers.

Based on these criteria, a decision will be made whether to set some or all of the remaining land use samplers to monitor storms totaling 0.1 inches of rainfall or greater.

D.2 EQUIPMENT AND METHODS

Stormwater Monitoring Site 24, known as Project 1202 Monitoring Station, was selected for the Low Flow Pilot Study. The Project 1202 site is located at a concrete box culvert. The site catchment drains based on an evaluation conducted in Monitoring Plan for 1996/1997 Low Flow Pilot (Woodward-Clyde and Larry Walker Associates, 1996) a 1.07 square mile watershed that is approximately 74 percent impervious. The land use in the watershed is approximately 42 percent commercial, 49 percent industrial and 9 percent vacant. Project 1202 was selected for this pilot study because, compared to the other land use stations, it produced the best runoff response to small events, it had high imperviousness, and it had the lowest and most consistent dry weather flows.

The sampling was conducted with the existing automatic water sampler. The sampler was programmed to start automatically based on the water depth reaching 0.125 feet (1.5 inches) as measured by the existing pressure transducer, and detection of 0.02 inches of rainfall by a tipping bucket rain gage. The sampler drew 1.0 liter aliquots on a flow-proportioned basis. An initial daily volume of 10,000 cubic feet of flow between aliquot collections was selected. Ten aliquots were sampled per bottle, and the sampler housed four 10 liter bottles. The sample collection pacing volume was changed to 5,000 cubic feet after receiving poor results from the first small storm of the season (Storm 2A). Sampling discontinued when either all sample aliquots were taken or when the sampler was manually turned off.

Rainfall estimates for storm volume were not available until two to three hours before an event. With the required set-up for the other elements of the Monitoring Program (i.e., bottle and ice placement, equipment problem solving, and field team mobilization), the sampler pacing volume could not be set based on anticipated storm size. The sampler pacing volume was, therefore, maintained at 5,000 cubic feet (that is after Storm 2A, see above) to ensure proper sampling of storms down to 0.1 inches.

The automatic sampler does not have telemetric communications. All programming and data transfer is conducted in the field. For this and other reasons discussed above, the sample collection pacing volume could not be modified in response to changes in forecasted rainfall amounts.

The sampler bottles were checked frequently, starting several hours after sampling began, to evaluate whether the bottles were full and needed to be changed. To sample any events with more than 0.25 inches of rain, the composite bottles were changed at least once during the sample collection. In the 1996-97 storm season, 8 of 11 storms were greater than 0.25 inches of rain.

The samples collected for the Low Flow Pilot Study were stored, handled and analyzed in accordance with the currently approved Storm Water/Urban Runoff Monitoring Plan. The analytical methods for the constituents analyzed in this study are listed in Table B-1. The complete methods are presented in Monitoring Plan for 1996/1997 Low Flow Pilot Study (Woodward-Clyde and Larry Walker Associates, 1996).

Table D-1. Analytical Methods for Constituents Analyzed in Low Flow Pilot Study

Class	Constituent	Sample Type	Method	DL	PQL	Units	Preservation	Holding Time
General								
	Ammonia	Comp	A350.3	0.1	0.1	mg/l	H_2SO_4	28 days
	Calcium	Comp	A215.2	1.0	1.0	mg/l	HNO_3	6 months
	Magnesium	Comp	C3500MgD	1.0	1.0	mg/l	HNO_3	6 months
	Potassium	Comp	A258.1	1.0	1.0	mg/l	HNO_3	6 months
	Sodium	Comp	A273.1	1.0	1.0	mg/l	HNO_3	6 months
	Bicarbonate	Comp	A310.1	2.0	2.0	mg/l	-	14 days
	Carbonate	Comp	A310.1	2.0	2.0	mg/l	-	14 days
	Chloride	Comp	B429	2.0	2.0	mg/l	-	28 days
	Fluoride	Comp	B429	0.1	0.1	mg/l	-	28 days
	Nitrate	Comp	B429	0.1	0.1	mg/l	-	48 hours
	Sulfate	Comp	B429	0.1	0.1	mg/l	-	48 hours
	Alkalinity	Comp	A310.1	4.0	4.0	mg/l	-	14 days
	Hardness	Comp	A130.2	2.0	2.0	mg/l	HNO_3 or H_2SO_4	6 months
	Dissolved Phosphorus	Comp	A365.2	0.05	0.05	mg/l	-	48 hours
	Total Phosphorus	Comp	A365.2	0.05	0.05	mg/l	H_2SO_4	28 days
	COD	Comp	A410.4	5	10	mg/l	H_2SO_4	28 days
	pH	Comp	A150.1	na	na		-	immed.
	NH3-N	Comp	A350.3	0.1	0.1	mg/l	H_2SO_4	28 days
	Nitrate-N	Comp	C4110B	0.1	0.5	mg/l	-	48 hours
	Nitrite-N	Comp	C4110B	0.01	0.03	mg/l	-	48 hours
	TKN	Comp	A351.4	0.1	0.1	mg/l	H_2SO_4	28 days
	Specific Conductance	Comp	A120.1	1	1	umhos/cm	-	immed.
	Total Dissolved Solids	Comp	A160.1	2.0	2.0	mg/l	-	7 days
	Turbidity	Comp	A180.1	0.1	0.1	NTU	-	48 hours
	Suspended Solids	Comp	A160.2	2.0	2.0	mg/l	-	7 days
	Vol.Sus.Solids	Comp	160.4	1.0	1.0	mg/l	-	7 days
	MBAS	Comp	A425.1	0.05	0.05	mg/l	-	48 hours
	Total Organic Carbon	Comp	A415.1	1.0	1.0	mg/l	HCl, H_2SO_4, or H_3PO_4	28 days
	BOD	Comp	A405.1	2.0	2.0	mg/l	-	48 hours
Metals								
	Dissolved Aluminum	Comp	A202.2	100	100	ug/l	HNO_3	6 months
	Total Aluminum	Comp	A202.2	100	100	ug/l	HNO_3	6 months
	Dissolved Antimony	Comp	A204.2	1	5	ug/l	HNO_3	6 months
	Total Antimony	Comp	A204.2	1	5	ug/l	HNO_3	6 months
	Dissolved Arsenic	Comp	A206.2	1	5	ug/l	HNO_3	6 months
	Total Arsenic	Comp	A206.2	1	5	ug/l	HNO_3	6 months
	Dissolved Barium	Comp	A208.2	1	10	ug/l	HNO_3	6 months
	Total Barium	Comp	A208.2	1	10	ug/l	HNO_3	6 months
	Dissolved Beryllium	Comp	A210.2	1	1	ug/l	HNO_3	6 months
	Total Beryllium	Comp	A210.2	1	1	ug/l	HNO_3	6 months
	Dissolved Boron	Comp	A212.3	100	100	ug/l	HNO_3	6 months
	Total Boron	Comp	A212.3	100	100	ug/l	HNO_3	6 months
	Dissolved Cadmium	Comp	A213.2	1	1	ug/l	HNO_3	6 months
	Total Cadmium	Comp	A213.2	1	1	ug/l	HNO_3	6 months

DL = Detection limit
PQL = Practical quantitation limit
na = not applicable
"-" = No preservation required other than cooling the sample to 4° C.

Table D-1. Analytical Methods for Constituents Analyzed in Low Flow Pilot Study

Class	Constituent	Sample Type	Method	DL	PQL	Units	Preservation	Holding Time
Metals (cont.)								
	Dissolved Chromium	Comp	A218.2	1	5	ug/l	HNO_3	6 months
	Total Chromium	Comp	A218.2	1	5	ug/l	HNO_3	6 months
	Dissolved Chromium +6	Comp		10	10	ug/l	-	24 hours
	Total Chromium +6	Comp		10	10	ug/l	-	24 hours
	Dissolved Copper	Comp	A220.1	1	5	ug/l	HNO_3	6 months
	Total Copper	Comp	A220.1	1	5	ug/l	HNO_3	6 months
	Dissolved Iron	Comp	A236.1	100	100	ug/l	HNO_3	6 months
	Total Iron	Comp	A236.1	100	100	ug/l	HNO_3	6 months
	Dissolved Lead	Comp	A239.2	1	5	ug/l	HNO_3	6 months
	Total Lead	Comp	A239.2	1	5	ug/l	HNO_3	6 months
	Dissolved Manganese	Comp	A243.1	50	50	ug/l	HNO_3	6 months
	Total Manganese	Comp	A243.1	50	50	ug/l	HNO_3	6 months
	Dissolved Mercury	Comp	A245.1	0.1	1	ug/l	HNO_3	28 days
	Total Mercury	Comp	A245.1	0.1	1	ug/l	HNO_3	28 days
	Dissolved Nickel	Comp	A249.2	1	5	ug/l	HNO_3	6 months
	Total Nickel	Comp	A249.2	1	5	ug/l	HNO_3	6 months
	Dissloved Selenium	Comp	A270.2	0.2	5	ug/l	HNO_3	6 months
	Total Selenium	Comp	A270.2	0.2	5	ug/l	HNO_3	6 months
	Dissolved Silver	Comp	A272.2	0.2	1	ug/l	HNO_3	6 months
	Total Silver	Comp	A272.2	0.2	1	ug/l	HNO_3	6 months
	Dissolved Thallium	Comp	A279.2	1	5	ug/l	HNO_3	6 months
	Total Thallium	Comp	A279.2	1	5	ug/l	HNO_3	6 months
	Dissolved Zinc	Comp	A289.1	10	50	ug/l	HNO_3	6 months
	Total Zinc	Comp	A289.1	10	50	ug/l	HNO_3	6 months
Semi-Volatile Organics								
	Bis(2-ethylhexyl)phthalate	Comp	525	3.0	3.0	ug/l	-	7 days
	All other SVOCs	Comp	525	0.5 - 5.0	0.5 - 5.0	ug/l	-	7 days
Pesticides								
	Organochlorine Pesticides & PCBs	Comp	D608	0.05 - 1.0	0.05 - 1.1	ug/l	-	7 days
	Diazinon	Comp	507	0.05	0.25	ug/l	-	7 days
	Chlorpyrifos	Comp	507	0.20	1.00	ug/l	-	7 days
	Other N- and P-Containing Pesticides	Comp	507	1.0 - 2.0	1.0 - 2.0	ug/l	-	7 days
	Carbofuran	Comp	531.1	5.0	5.0	ug/l	-	7 days
	Chlorinated Herbicides & Bentazon							
	2,4-D	Comp	515.1	10.0	10.0	ug/l	-	7 days
	2,4,5-TP	Comp	515.1	1.0	1.0	ug/l	-	7 days
	Bentazon	Comp	515.1	2.0	2.0	ug/l	-	7 days
	Glyphosate	Comp	547	25	50	ug/l	$Na_2S_2O_3$	14 days

DL = Detection limit
PQL = Practical quantitation limit
na = not applicable
"-" = No preservation required other than cooling the sample to 4° C.

D.3 RESULTS

During the 1996-97 storm season, eleven events were monitored at the Project 1202 site. Of these eleven events, ten were sampled. The monitored storm events ranged in size from 0.13 inches to 4.25 inches of rainfall. In the 1996-97 storm season, 8 of 11 storms were greater than 0.25 inches of rain. Hydrographs for each event are presented in Attachment D-1. A summary of the events is presented below in Table D-2. Water quality results are presented in Table D-3.

Table D-2. Summary of the events monitored for the Low Flow Pilot Study.

Event No.	Date	Precipitation (in)	Runoff Volume (1000's of c.f.)	Antecedent Dry Period (days)	No. of Bottle Replacements(1)
1	10/29/96	0.75(2)	1,658	231	4
2	11/20/96	2.00	2,282	22	3
2A	12/5/96	0.16	113	13	1
3	12/9/96	4.25	5,205	3	3
4	12/22/96	0.15	60	10	1
5	12/27/96	0.84	1,053	5	3
5A	1/1/97	0.76	716	5	1
6	1/12/97	2.49	3,256	6	8
7	1/21/97	1.08 (3)	1,014(3)	5	4 (2)
8	1/25/97	0.98	4,560(4)	5	n/s
8A	2/10/97	0.13	265	16	2

Notes:

(1) number of actual bottle replacements, not number required.
(2) Precipitation value for Los Angeles River at Wardlow site (4 miles away)
(3) totals at time that the sampler malfunctioned.
(4) runoff volume not reliable due to pressure transducer problems.
n/s = not sampled.
A = small storm events not sampled at every station.

Table D-3. Summary of Results for 1996-1997 Low Flow Pilot Study

DPW SAMPLE NO.						58960	59022	59045	59103	59153	59163	59280	59210	59251	59325	
STATION NO.						S24	S24	S24	S24	S24	S24	S24	S24	S24	S24	
STATION NAME						Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	
DATE SAMPLED						10/30/96	11/21/96	12/09/96	12/21/96	12/05/96	12/27/96	01/01/97	01/12/97	01/22/97	02/10/97	
DATE DELIVERED					Sample	10/30/96	11/21/96	12/10/96	12/23/96	12/06/96	12/27/96	01/06/97	01/13/97	01/22/97	02/11/97	
STORM NO.	EPA_Method	DL	PQL	Units	Type	1	2	3	4	2A	5	5A	6	7	8A	Mean
General																
Ammonia	A350.3	0.1	0.1	mg/l	Comp	0.313	0.468	0.368	3.24	2.26	0.275	0.543	0.235	0.39	1.33	0.94
Calcium	A215.2	1.0	1.0	mg/l	Comp	12.02	4.4	6.41	16.51	12.83	6.41	4.81	3.85	8.82	14.8	9.1
Magnesium	C3500MgD	1.0	1.0	mg/l	Comp	1.94	2.18	0.58	3.31	1.94	0.486	0.97	1.75	1.75	3.79	1.87
Potassium	A258.1	1.0	1.0	mg/l	Comp	3.3	2.53	1.8	6.88	3.95	1.86	0.38	0.82	1.53	2.05	2.51
Sodium	A273.1	1.0	1.0	mg/l	Comp	10.2	5.9	3.6	31.8	21	5.58	3.2	3.33	20.9	18.5	12.40
Bicarbonate	A310.1	2.0	2.0	mg/l	Comp	12.84	17.1	16.1	38.52	32.1	18.2	12.8	12.8	23.5	38.5	22.2
Carbonate	A310.1	2.0	2.0	mg/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Chloride	B429	2.0	2.0	mg/l	Comp	11.7	6.57	5.45	43.3	17.5	5.62	3.67	5.59	25.8	16.6	14.18
Fluoride	B429	0.1	0.1	mg/l	Comp	0.13	0.108	0	0.22	0.237	0	0	0	0.108	0.148	0.10
Nitrate	B429	0.1	0.1	mg/l	Comp	5.73	2.13	1.54	5.29	8.22	2.53	1.44	1.89	2.21	13.5	4.45
Sulfate	B429	0.1	0.1	mg/l	Comp	11.5	6.87	5.53	29.7	19.1	4.37	5.72	4.44	10.9	17.5	11.6
Alkalinity	A310.1	4.0	4.0	mg/l	Comp	12.84	17.1	16.1	38.52	32.1	18.2	12.8	12.8	23.5	38.5	22.2
Hardness	A130.2	2.0	2.0	mg/l	Comp	38	20	18.4	54.8	40	18	16	17	29	52	30
Dissolved Phosphorus	A365.2	0.05	0.05	mg/l	Comp	0.319	0.242	0.07	0.59		0.14		0.071	0.23	0.44	0.26
Total Phosphorus	A365.2	0.05	0.05	mg/l	Comp	0.793	0.585	0.38	1.1		0.41		0.324	0.45	1.22	0.66
COD	A410.4	5	10	mg/l	Comp	89.8	133	108.5	81.6	201.3	57.9	17	70.73	50.98	147	95.78
pH	A150.1	0-14	0-14		Comp	6.63	6.61	6.54	6.89	7.23	6.53	6.6	6.81	7.03	6.93	6.78
NH3-N	A350.3	0.1	0.1	mg/l	Comp	0.259	0.387	0.3	2.68	1.87	0.227	0.449	0.194	0.322	1.1	0.779
Nitrate-N	C4110B	0.1	0.5	mg/l	Comp	1.29	0.481	0.348	1.2	1.86	0.572	0.325	0.427	0.499	3.051	1.005
Nitrite-N	C4110B	0.01	0.03	mg/l	Comp	0.05	0.048	0.042	0.171	0.206	0.058	0.043	0.046	0.108	0.21	0.098
TKN	A351.4	0.1	0.1	mg/l	Comp	2.2	2.72	1.81	5.08	5.75	1.82	1.36	1.846	1.78	5.18	2.95
Specific Conductance	A120.1	1	1	umhos/cm	Comp	136	94.6	60	325	210	78		70	183	229	154
Total Dissolved Solids	A160.1	2.0	2.0	mg/l	Comp	92	76	38	202	138	50		46	110	150	100
Turbidity	A180.1	0.1	0.1	NTU	Comp	10.9	25	24	46	24	37	23	29	25	140	38
Total Suspended Solids	A160.2	2.0	2.0	mg/l	Comp	127	107	86	155	57	129		119	71	1160	223
Volatile Suspended Solids	160.4	1.0	1.0	mg/l	Comp	45	42	32	65	23	47		48	22	122	50
MBAS	A425.1	0.05	0.05	mg/l	Comp	0.31	0.096	0.068	0.161	0.211	0.083		0.1	0.13	0.135	0.144
Total Organic Carbon	A415.1	1.0	1.0	mg/l	Comp	17.05	12.2	5.6	7.4	33.1	5.14	2.4	2.52	8.09	24.21	11.77
BOD	A405.1	2.0	2.0	mg/l	Comp	28	31	20	16.8	35.87	23.5		44	32.7	30.8	29.2
Metals																
Dissolved Aluminum	A202.2	100	100	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Aluminum	A202.2	100	100	ug/l	Comp	2540	1270					0	0	0	1029	807
Dissolved Antimony	A204.2	1	5	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Antimony	A204.2	1	5	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Dissolved Arsenic	A206.2	1	5	ug/l	Comp	0	0	0	1	0	0	0	0	0	0	0
Total Arsenic	A206.2	1	5	ug/l	Comp	0	0	0	2	0	0	0	0	0	2	0
Dissolved Barium	A208.2	1	10	ug/l	Comp	0	0	10	10	0	0	11	0	16	40	9
Total Barium	A208.2	1	10	ug/l	Comp	0	0	23	10	0	0	20	0	41	87	18
Dissolved Beryllium	A210.2	1	1	ug/l	Comp		0					0	0	0	0	0
Total Beryllium	A210.2	1	1	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Dissolved Boron	A212.3	100	100	ug/l	Comp	0	0	0	182	110	0	0	0	100	0	39
Total Boron	A212.3	100	100	ug/l	Comp	0	165	0	278	158	0	0	0	103	0	70
Dissolved Cadmium	A213.2	1	1	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Cadmium	A213.2	1	1	ug/l	Comp	0	0	0	1	0	0	0	0	0	0	0
Dissolved Chromium	A218.2	1	5	ug/l	Comp	0	0	0	0	0	0	5	2	2	1	1
Total Chromium	A218.2	1	5	ug/l	Comp	12	0	5	2	0	4	6	3	3	4	4
Dissolved Chromium +6		10	10	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Chromium +6		10	10	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0

DL - Detection limit
PQL - Practical quantitation limit

Table D-3. Summary of Results for 1996-1997 Low Flow Pilot Study

DPW SAMPLE NO.						58960	59022	59045	59103	59153	59163	59280	59210	59251	59325	
STATION NO.						S24	S24	S24	S24	S24	S24	S24	S24	S24	S24	
STATION NAME						Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	Project 1202	
DATE SAMPLED						10/30/96	11/21/96	12/09/96	12/21/96	12/05/96	12/27/96	01/01/97	01/12/97	01/22/97	02/10/97	
DATE DELIVERED					Sample	10/30/96	11/21/96	12/10/96	12/23/96	12/06/96	12/27/96	01/06/97	01/13/97	01/22/97	02/11/97	
STORM NO.	EPA_Method	DL	PQL	Units	Type	1	2	3	4	2A	5	5A	6	7	8A	Mean
Metals (cont.)																
Dissolved Copper	A220.1	1	5	ug/l	Comp	12	10	0	16	24	2	5	6	4	16	10
Total Copper	A220.1	1	5	ug/l	Comp	60	24	13	990	51	19	7	9	15	34	122
Dissolved Iron	A236.1	100	100	ug/l	Comp	0	140	0	120	0	150	0	0	0	0	41
Total Iron	A236.1	100	100	ug/l	Comp	3930	1.4	410	700	1100	600	130	270	658	1720	952
Dissolved Lead	A239.2	1	5	ug/l	Comp	0	0	0	0	3	0	0	0	0	0	0
Total Lead	A239.2	1	5	ug/l	Comp	48	13	14	9	19	6	4	6	9	8	14
Dissolved Manganese	A243.1	50	50	ug/l	Comp	30	0	0	0	0	0	0	0	0	0	3
Total Manganese	A243.1	50	50	ug/l	Comp	160	40	0	0	0	0	0	0	0	0	20
Dissolved Mercury	A245.1	0.1	1	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Mercury	A245.1	0.1	1	ug/l	Comp	0	1	0	0	0	0	2	0	0	0	0
Dissolved Nickel	A249.2	1	5	ug/l	Comp	0	0	0	5	6	0	1	0	1	2	2
Total Nickel	A249.2	1	5	ug/l	Comp	21	0	7	9	16	3	5	4	4	7	8
Dissloved Selenium	A270.2	0.2	5	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Selenium	A270.2	0.2	5	ug/l	Comp	0	0	0	0	0	0	0	1	0	0	0
Dissolved Silver	A272.2	0.2	1	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Silver	A272.2	0.2	1	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Dissolved Thallium	A279.2	1	5	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Total Thallium	A279.2	1	5	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0
Dissolved Zinc	A289.1	10	50	ug/l	Comp	590	300	250	630	450	220	17	10	0	0	247
Total Zinc	A289.1	10	50	ug/l	Comp	1010	350	250	760	580	860	180	200	204	300	469
Semi-Volatile Organics																
Bis(2-ethylhexyl)phthalate	525	3.0	3.0	ug/l	Comp	3.7	3.2	31.5	8.6	28.1	3.8		12.2	17.5	5.9	12.7
All other SVOCs	525	0.5 - 5.0	0.5 - 5.0	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Pesticides																
Organochlorine Pesticides & PCBs	D608	0.05 - 1.0	0.05 - 1.1	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Diazinon	507	0.05	0.25	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Chlorpyrifos	507	0.20	1.00	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Other N- and P-Containing Pesticides	507	1.0 - 2.0	1.0 - 2.0	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Carbofuran	531.1	5.0	5.0	ug/l	Comp	0	0	0	0	0	0			0	0	0
Chlorinated Herbicides & Bentazon																
2,4-D	515.1	10.0	10.0	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
2,4,5-TP	515.1	1.0	1.0	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Bentazon	515.1	2.0	2.0	ug/l	Comp	0	0	0	0	0	0		0	0	0	0
Glyphosate	547	25	50	ug/l	Comp	0	0	0	0	0	0	0	0	0	0	0

DL - Detection limit
PQL - Practical quantitation limit

The following problems occurred with the sampling equipment. For Storm 1, the adjacent triggering precipitation gauge was not yet operational. The flow record was inconsistent during Storm 7, which was the result of a calibration problem. For this event, data were analyzed for the first portion of the stormflow (shaded dark in the hydrograph in Attachment D-2). The calibration problem continued through Storm 8 and was fixed in early February before Storm 8A.

During the larger events the small pacing volume prevented the samplers from taking the correct number of samples. The sampler typically spends 2.5 minutes in the sampling mode once triggered by the flow meter. The flow meter will not begin to accumulate runoff volume for the next sample until the 2.5 minute sampling cycle is complete. There is, therefore, a down time following each pumping cycle. When the pacing volume is small and the runoff is high, the number of samples obtained is less than the target. This occurred in many of the larger events.

The sampler pacing for Storms 4, 5A, and 6 has been plotted to show this effect (Attachment D-2). In these figures the diamonds represent the theoretical sampler pacing assuming no down time. The triangles represent the theoretical sampler pacing with a 2.5 minute down time after each sample. Finally, the actual pacing is plotted with tick marks on the x-axis. All numbers above the symbols represent the number of samples taken during one hour.

During Storm 4 (0.15 inches of rain) the sampler collected three less samples than the calculated theoretical pacing. For Storm 5A (0.76 inches of rain) the sampler took one less sample than desired. However, for Storm 6 (2.49 inches of rain) the sampler took over 40 samples less than it theoretically should have. This figure does not include the periods of time not sampled when the bottles were completely filled and not yet replaced.

The water quality constituents analyzed showed some trends with storm size. A few higher concentrations than normal were seen in Storm 8A (0.13 inches rain). The composite sample for this event had the highest measured values of total suspended solids (TSS), turbidity, nitrate, total phosphorus, and hardness, while all other constituents were within the ranges of the other samples (Table D-3).

In terms of concentration of the constituents monitored, the smaller storms produced higher levels of some of the constituents than the medium to large storms. This effect is shown in Figures D-1 through D-4. It can be seen that the concentrations of nitrate and total phosphorus are higher in the smaller storms than the larger storms (Figures D-1 and D-2). The concentration of total suspended solids was highest for one of the small rainfall events (Storm 8A), but otherwise there is no trend with storm size (Figure D-3). The concentration of total metals (total zinc shown as an example) do not exhibit a trend with storm size (Figure D-4).

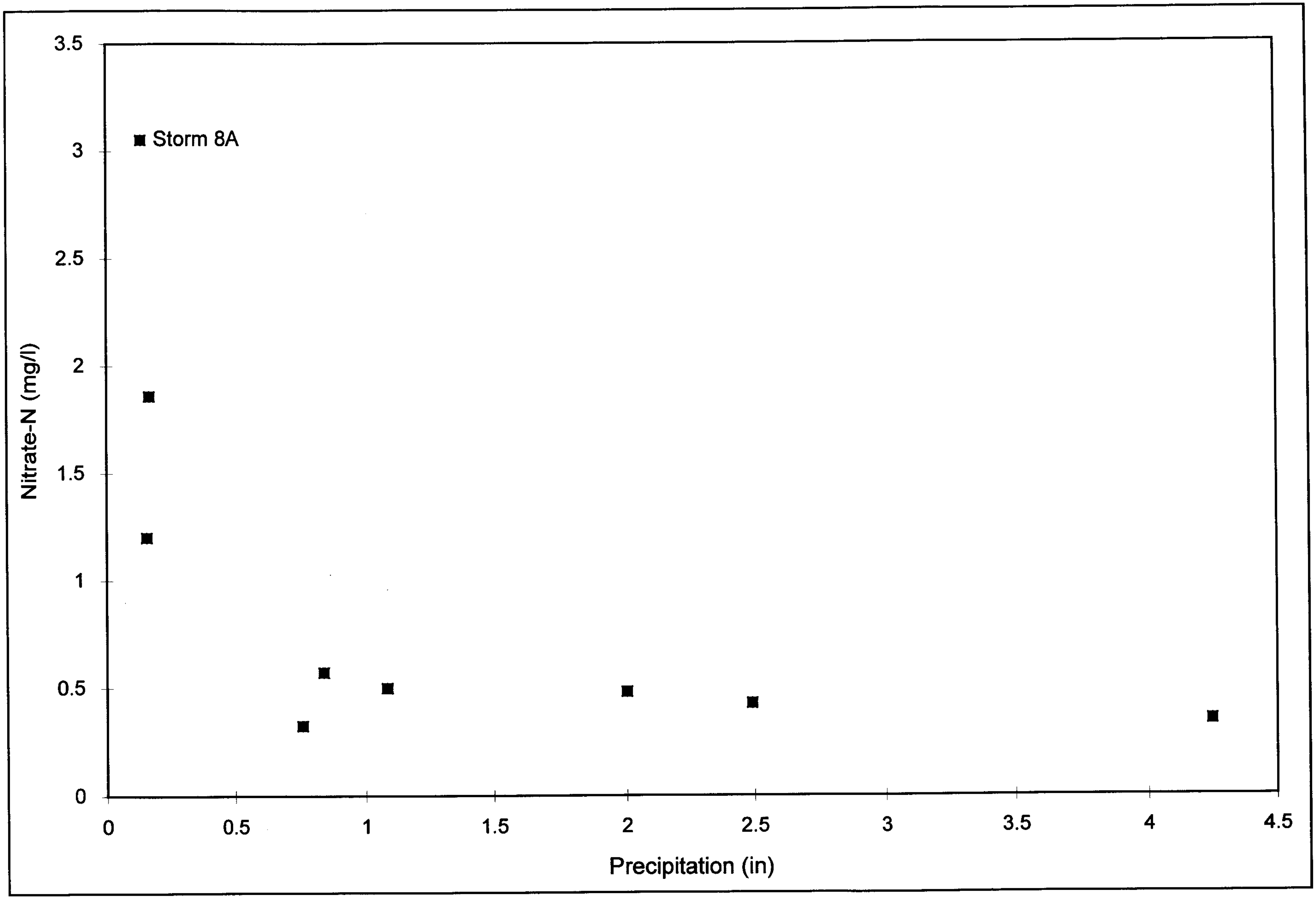


Figure D-1. Event concentrations of nitrate-N for nine storms at the Low Flow Pilot Study site (Project 1202).

b_figs.xls

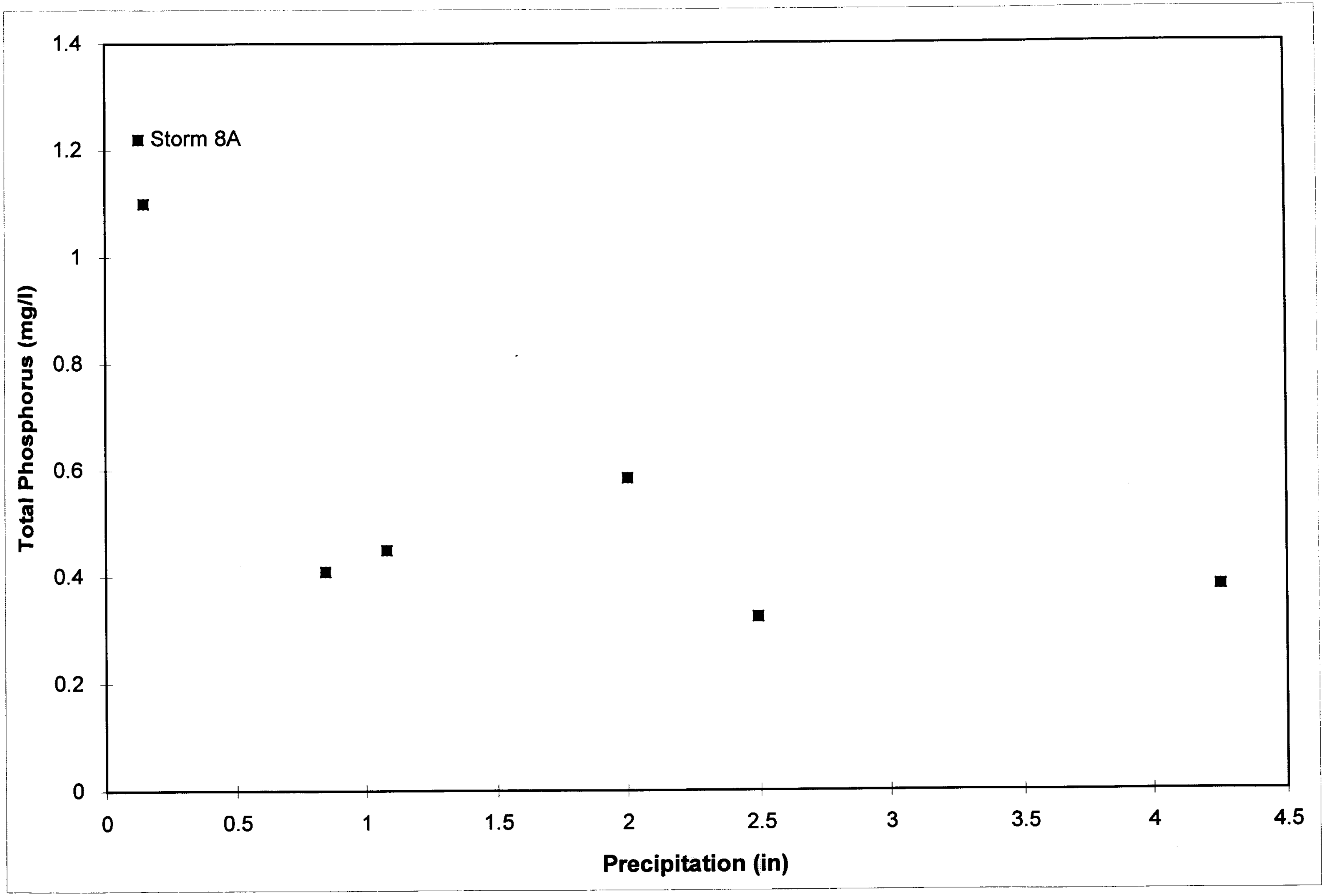


Figure D-2. Event concentrations of total phosphorus for nine storms at the Low Flow Pilot Study site (Project 1202).
B_figs

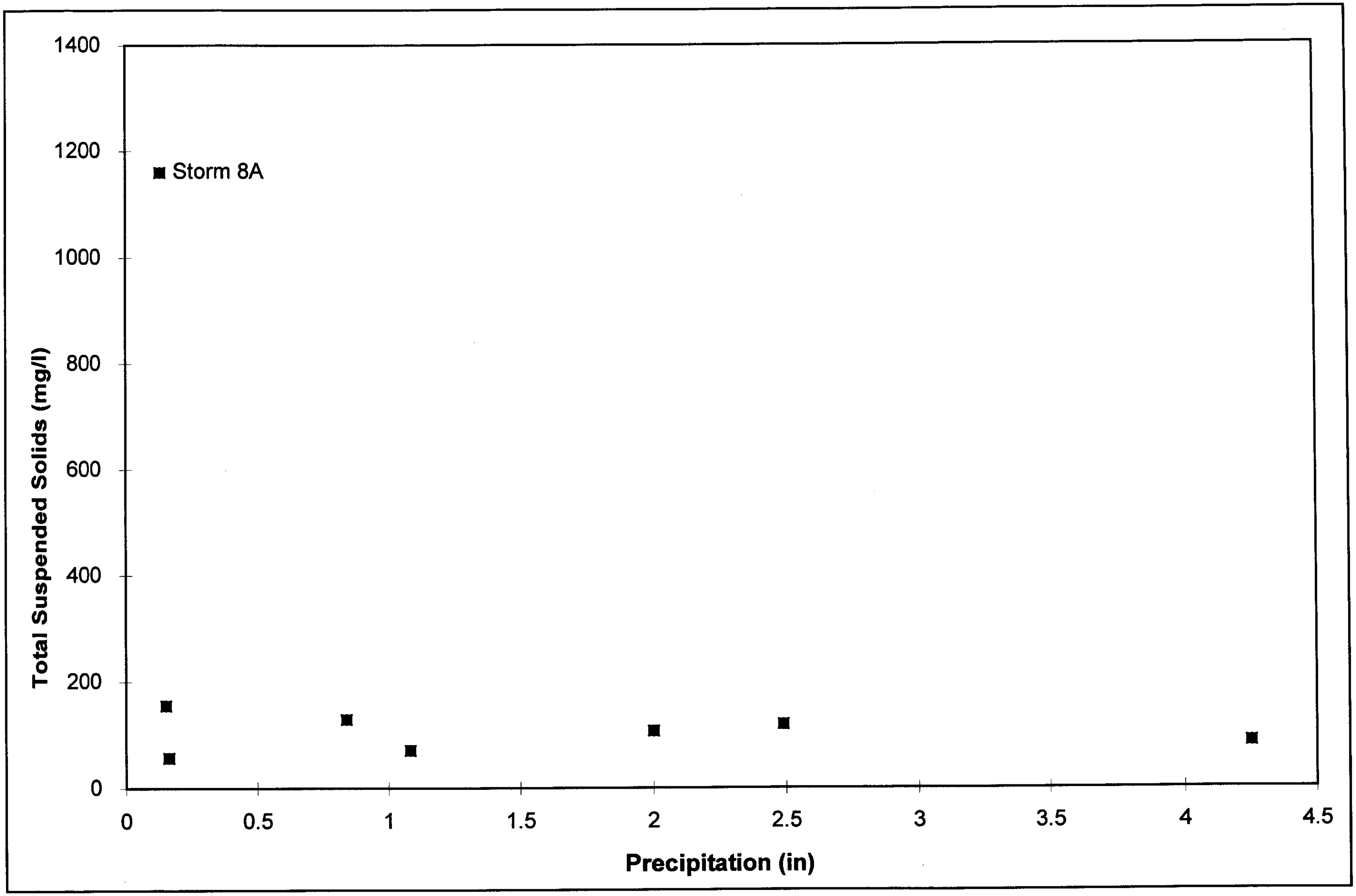


Figure D-3. Event concentrations of total suspended solids for nine storms at the Low Flow Pilot Study site (Project 1202).

b_figs.xls

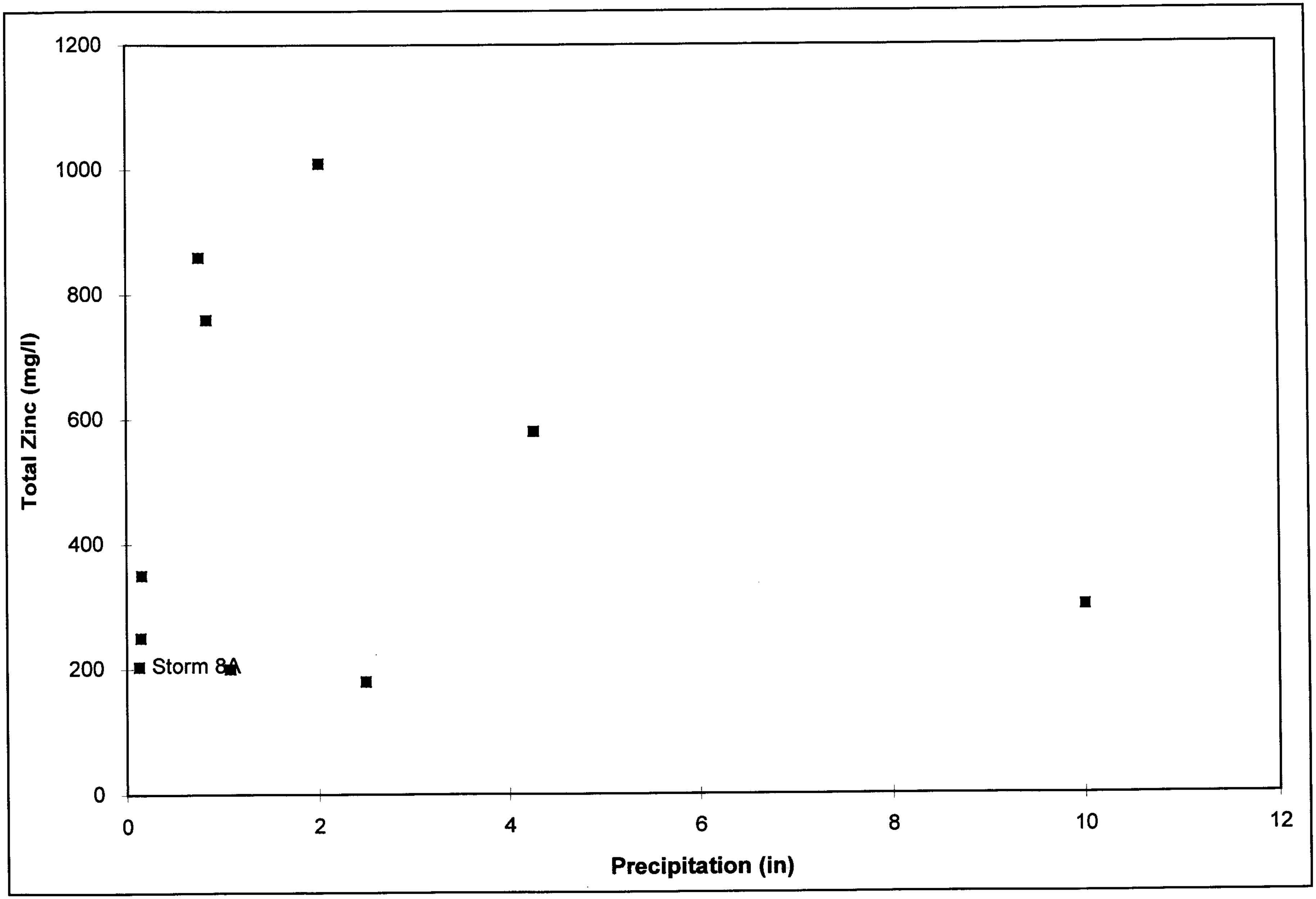


Figure D-4. Event concentrations of total zinc for nine storms at the Low Flow Pilot Study site (Project 1202).
b_figs.xls

Field crews generally spent more time (by a factor of 2-3) on the sampling for this pilot study than any other sampling element of the Monitoring Program. Due to the small requirements for sampler pacing volume, sample bottles needed to be changed frequently throughout an event. During one event the crews needed to set up new bottles eight times (Table D-2). Transportation to and from sites during wet weather proved to be extremely time consuming. During the larger events, field crews had to handle and label many more bottles. The laboratory had to composite many more 2.5 gallon sample bottles, which also was very labor intensive.

Often the sample bottles were entirely filled and sampling discontinued for some time when field crews arrived at the sites. Thus, storm event coverage for the medium and large storm events was sacrificed to accommodate the 0.1 inches criterion.

D.4 CONCLUSIONS AND RECOMMENDATION

The conclusions presented below address the three criteria used to evaluate the effectiveness of 0.1 inches and greater event monitoring.

The operational effectiveness of the sampler

Sampler operational effectiveness dropped significantly for the Low Flow Pilot Study site. Although equipment failures were generally not a factor in this study, the equipment was not effective when the pacing volume was set so low. Due to the down time of the flow meter during the sampling cycle, samples were often missed during the highest flow rates. With the required pacing, bottles filled quickly and needed to be replaced frequently during events. With telemetry at the station and a trained staff person, the pacing volume could be charged depending on anticipated storm size. The sampling equipment should operate effectively for small storms, as evidenced by Storms 2A (0.16 inches), 4 (0.15 inches), and 8A (0.13 inches).

The feasibility and effectiveness of sample retrieval and transport

Overall, requiring that the smallest monitored storm be reduced from 0.25 inches to 0.1 inches resulted in extremely difficult sample retrieval and transport for field crews. Bottles needed to changed frequently during events, resulting in extensive travel on wet roads during the storms. For medium to large events the laboratory had to composite numerous 2.5 gallon bottles. If the pacing problem could be solved with telemetry and extra staff, the sample retrieval and transport would not be as burdensome for sampling events down to 0.1 inches.

The ability to reprogram and maintain this setting at other samplers

It would be relatively easy to reprogram other land use stations to sample 0.1 inches and larger storms. However, as shown in *Monitoring Plan for 1996/1997 Low Flow Pilot Study* (Woodward-Clyde and Larry Walker Associates, 1996), most of these stations would not effectively monitor the storms in the 0.1 to 0.25 inches range. This is because the flow at many stations do not respond well to small storms and also have excessive dry weather flows. There is only one other station that could potentially handle the 0.1 inches criteria as reported in the monitoring plan report. This station is Dominguez Channel (S23). Note that telemetry, tipping bucket rain gauges, and new samplers would need to be added to this station to perform the low flow monitoring. The current samplers cannot accommodate telemetry so they would need to be replaced.

Recommendation

Based on the three criteria discussed above, we recommend that all land use sites be monitored for storms 0.25 inches and greater for the duration of the 1996 Municipal Permit. It is our opinion that the 0.1 inches sampling will not be effective unless stations can be provided with telemetry. To convert stations to telemetry, sampling units will need to be replaced, which will be expensive, due to an incompatibility with telemetry. In this case, only two of the seven existing stations (Project 1202 and Dominguez Channel) could be monitored for storm over 0.1 inches, since the five other sites either have inadequate hydrologic responses to small events, low imperviousness, or high and variable dry weather flows.

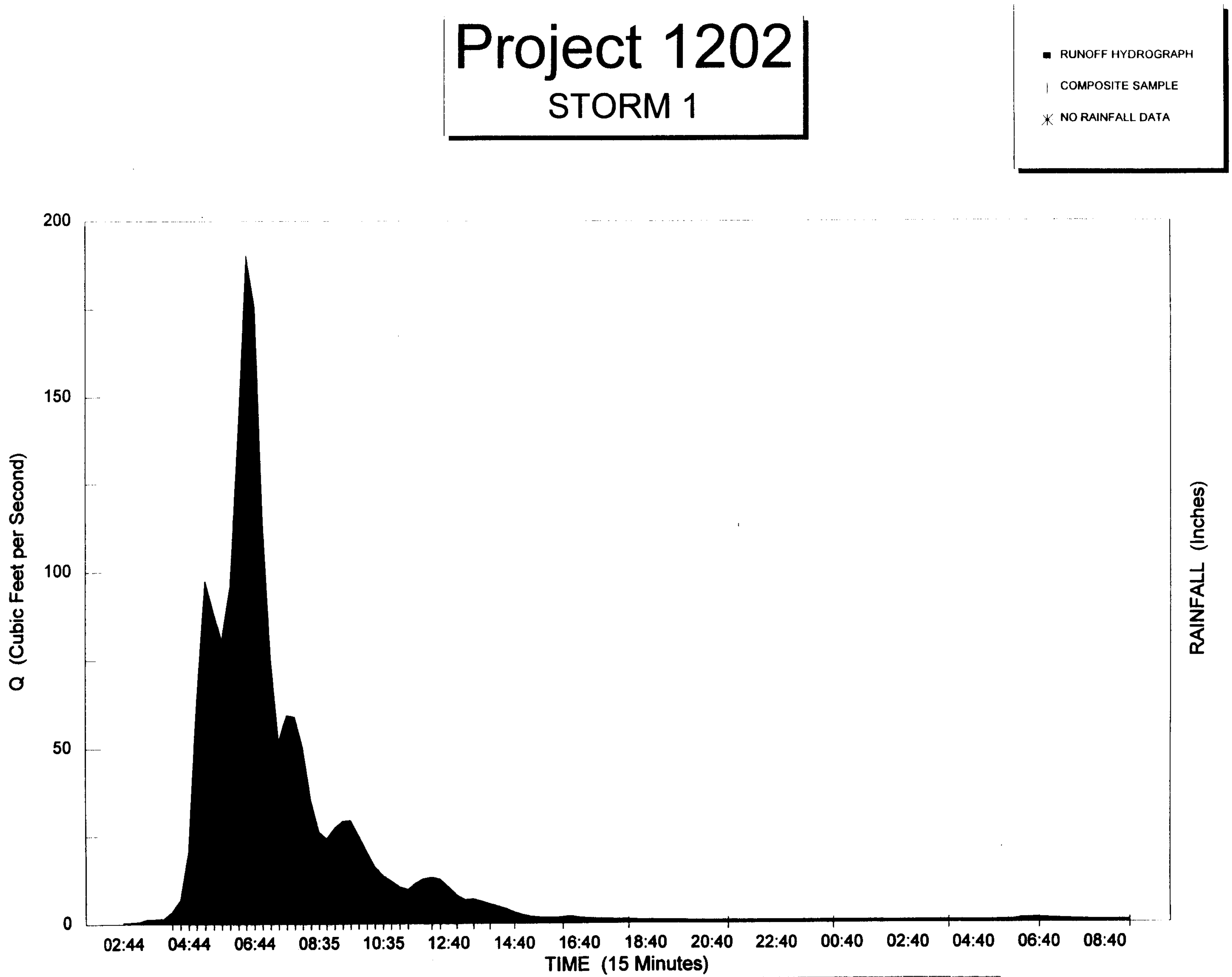
REFERENCES

Woodward Clyde Consultants. 1996. Evaluation of analytes and QA/QC specifications for monitoring program. Report prepared for Los Angeles County Department of Public Works, Alhambra, CA, December 1996.

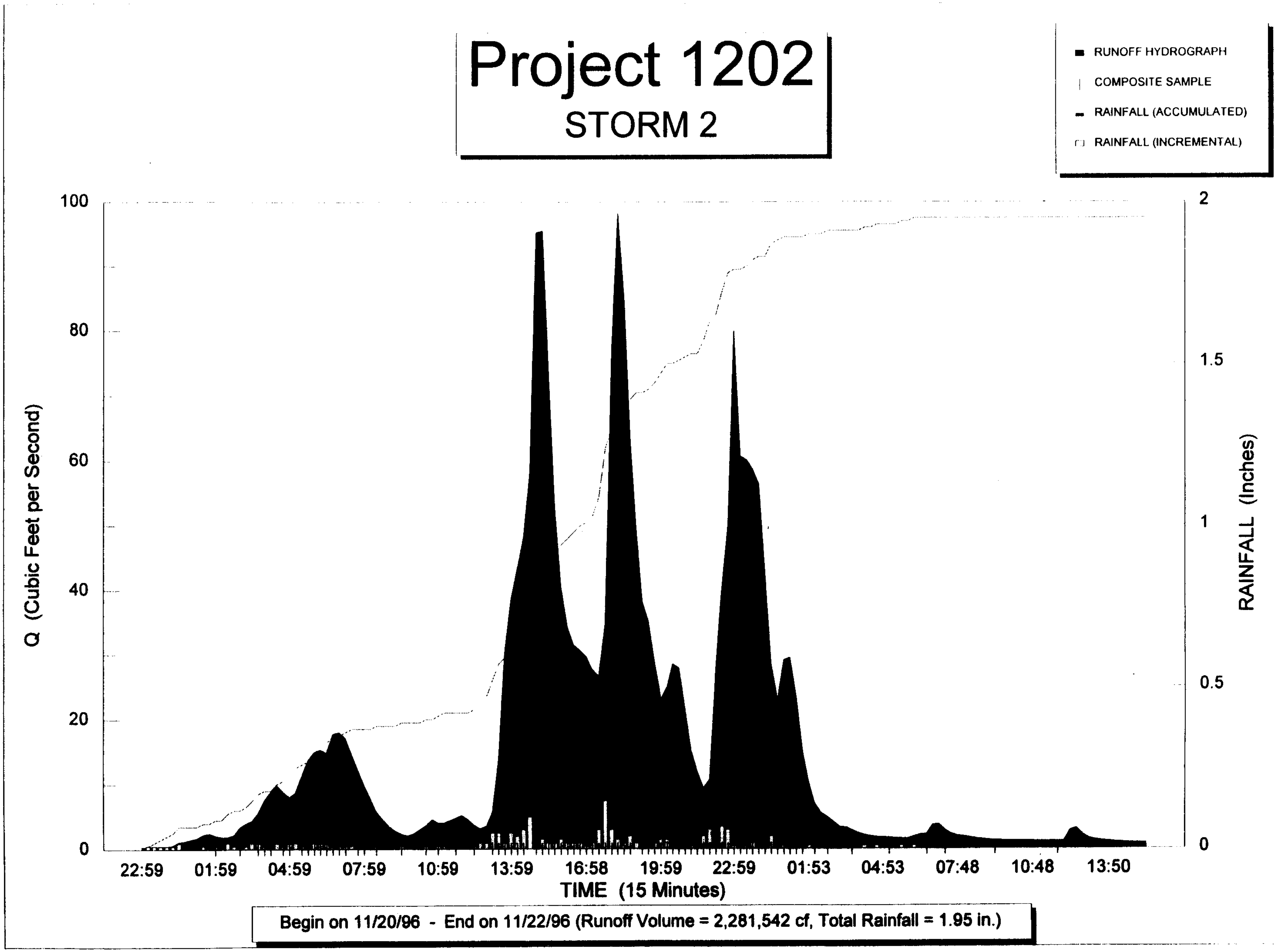
Woodward Clyde Consultants and Larry Walker Associates. 1996. Monitoring plan for 1996/1997 low flow pilot study. Prepared for Los Angeles County Department of Public Works, Alhambra, CA, November 1996.

ATTACHMENT D-1

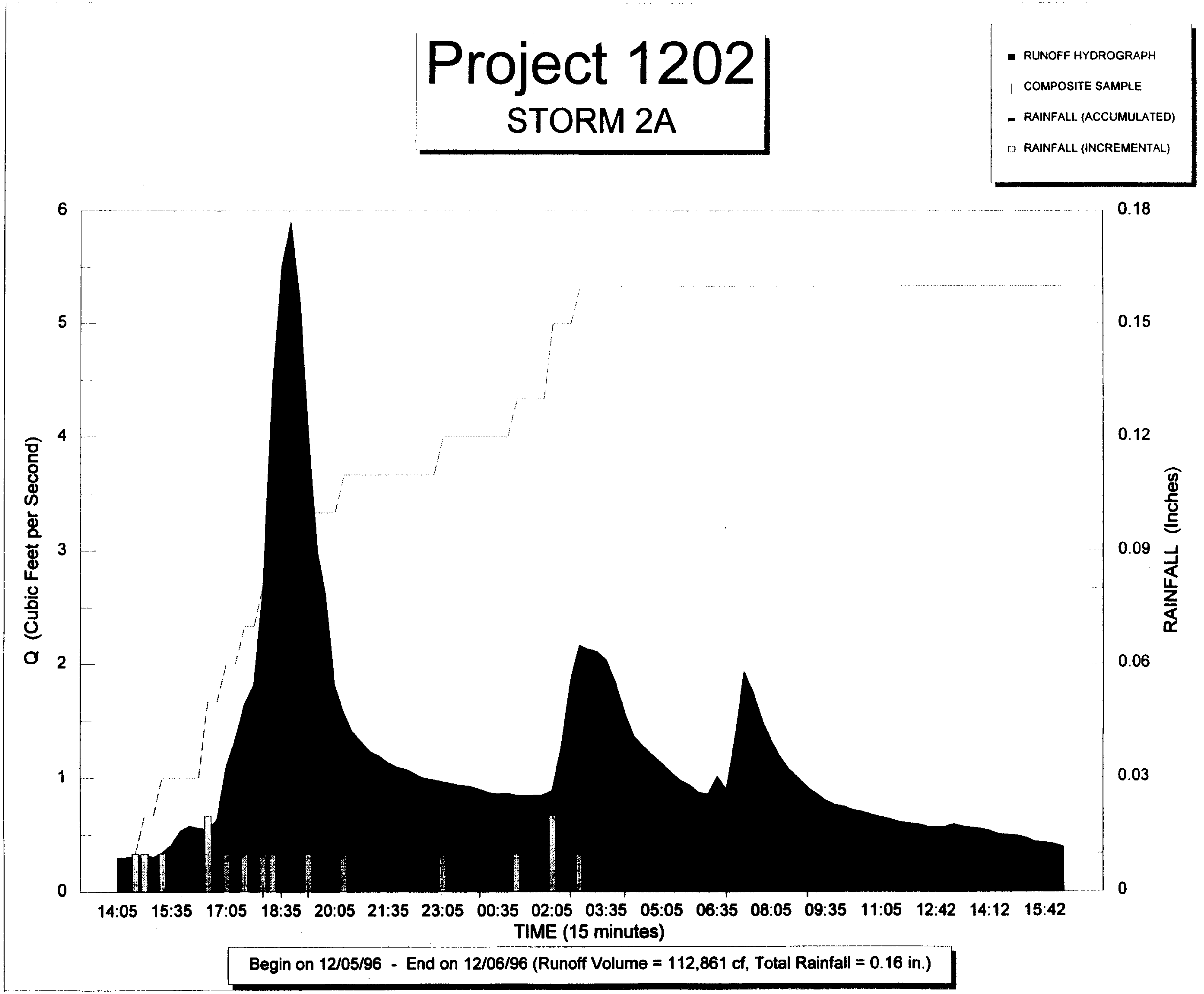
Project 1202
STORM 1

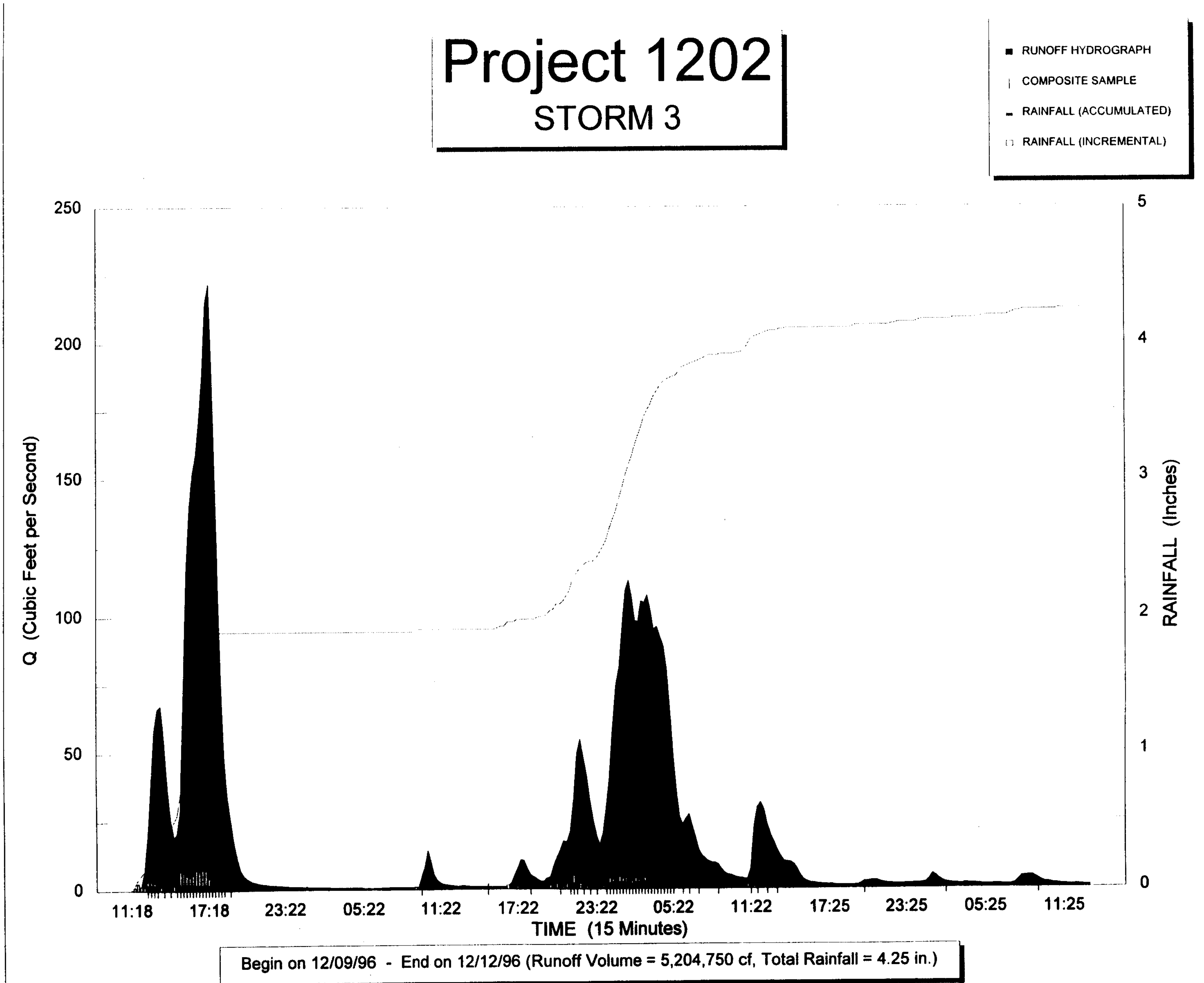


Begin on 10/29/96 - End on 10/30/96 (Runoff Volume = 1,658,370 cf, Total Rainfall = not available)

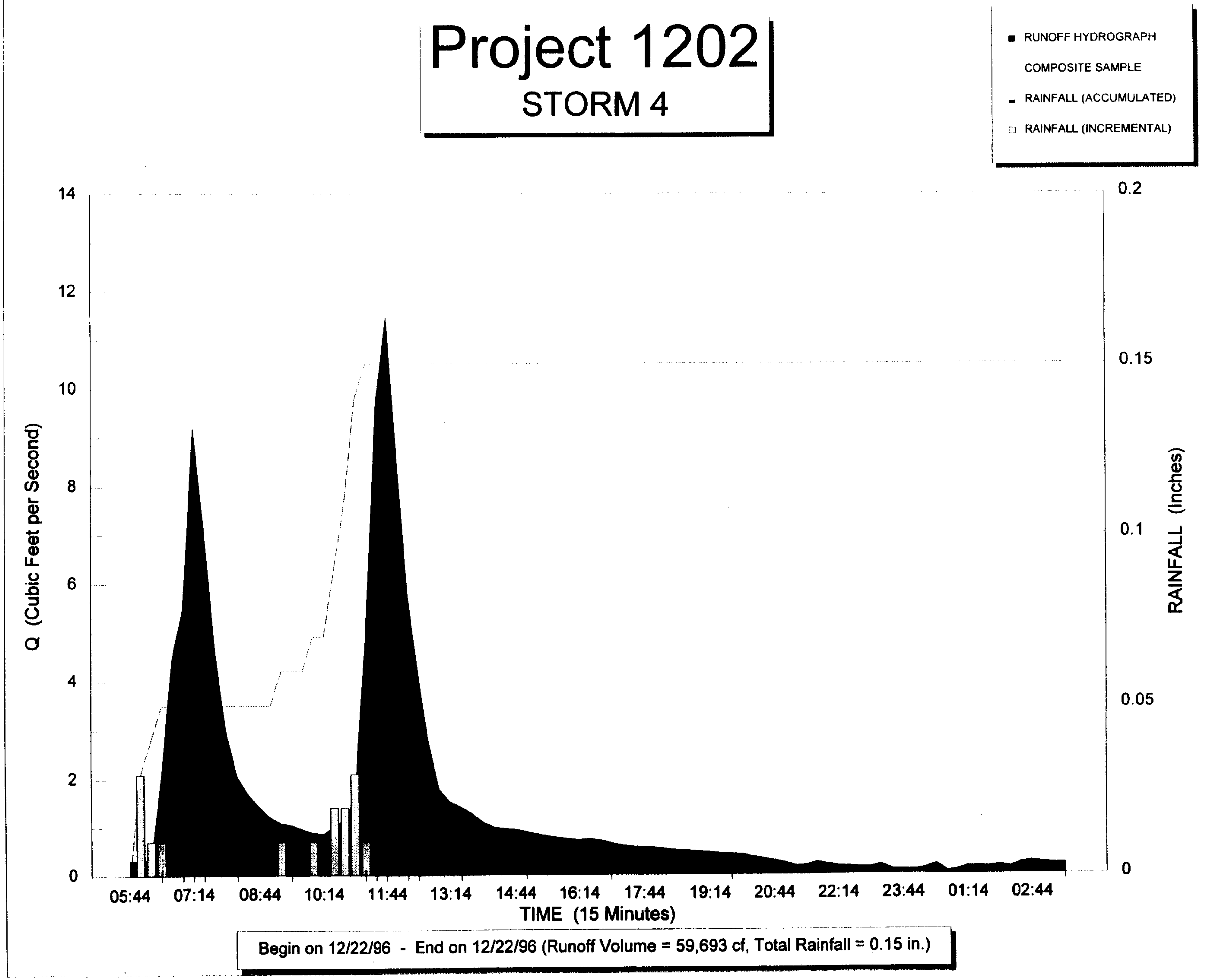


C:\123\SIGMA\24\24961130.WK4 [laptop]

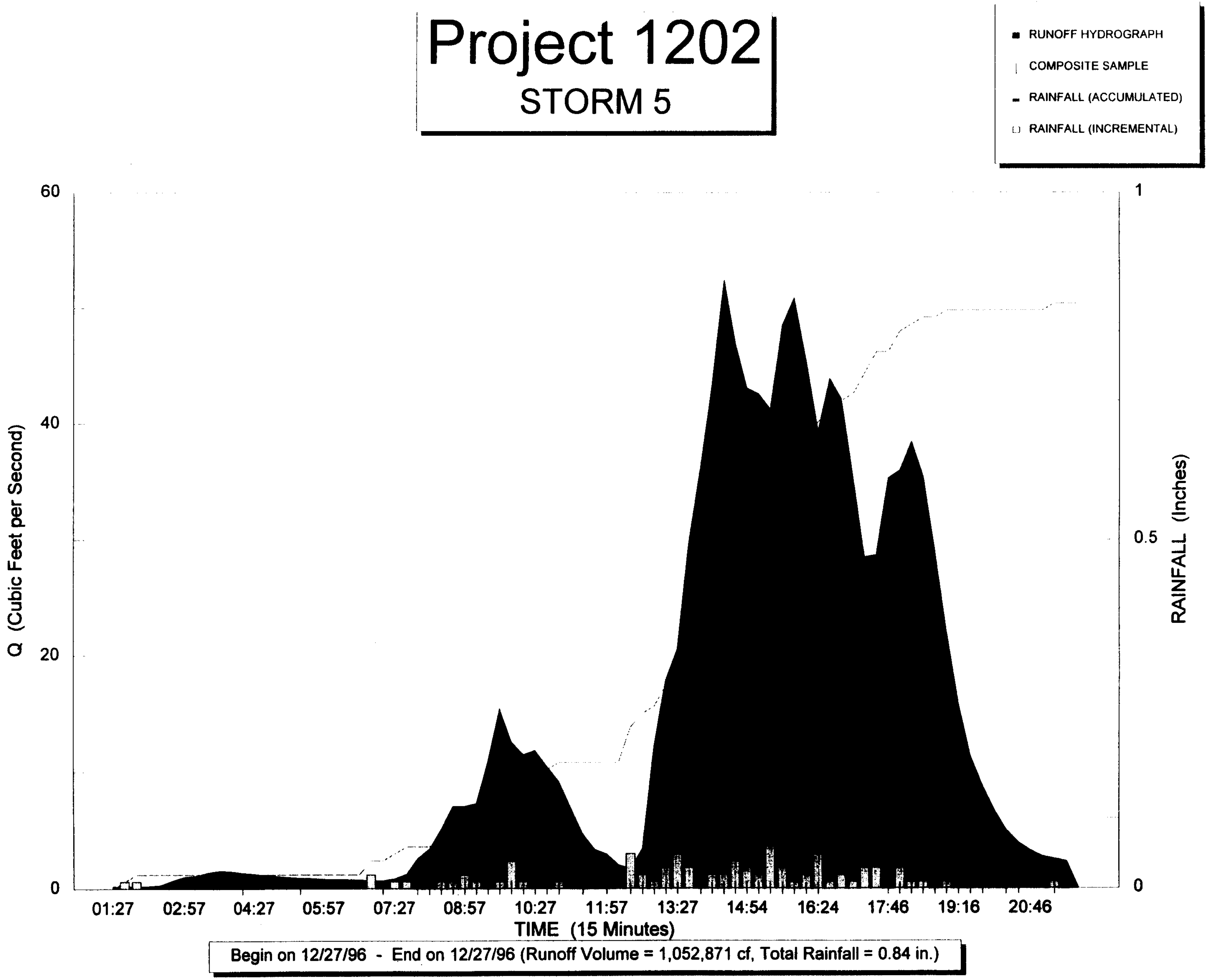

Project 1202
STORM 2A
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
Q (Cubic Feet per Second)
RAINFALL (Inches)
0
1
2
3
4
5
6
0.03
0.06
0.09
0.12
0.15
0.18
14:05
15:35
17:05
18:35
20:05
21:35
23:05
00:35
02:05
03:35
05:05
06:35
08:05
09:35
11:05
12:42
14:12
15:42
TIME (15 minutes)
Begin on 12/05/96 - End on 12/06/96 (Runoff Volume = 112,861 cf, Total Rainfall = 0.16 in.)



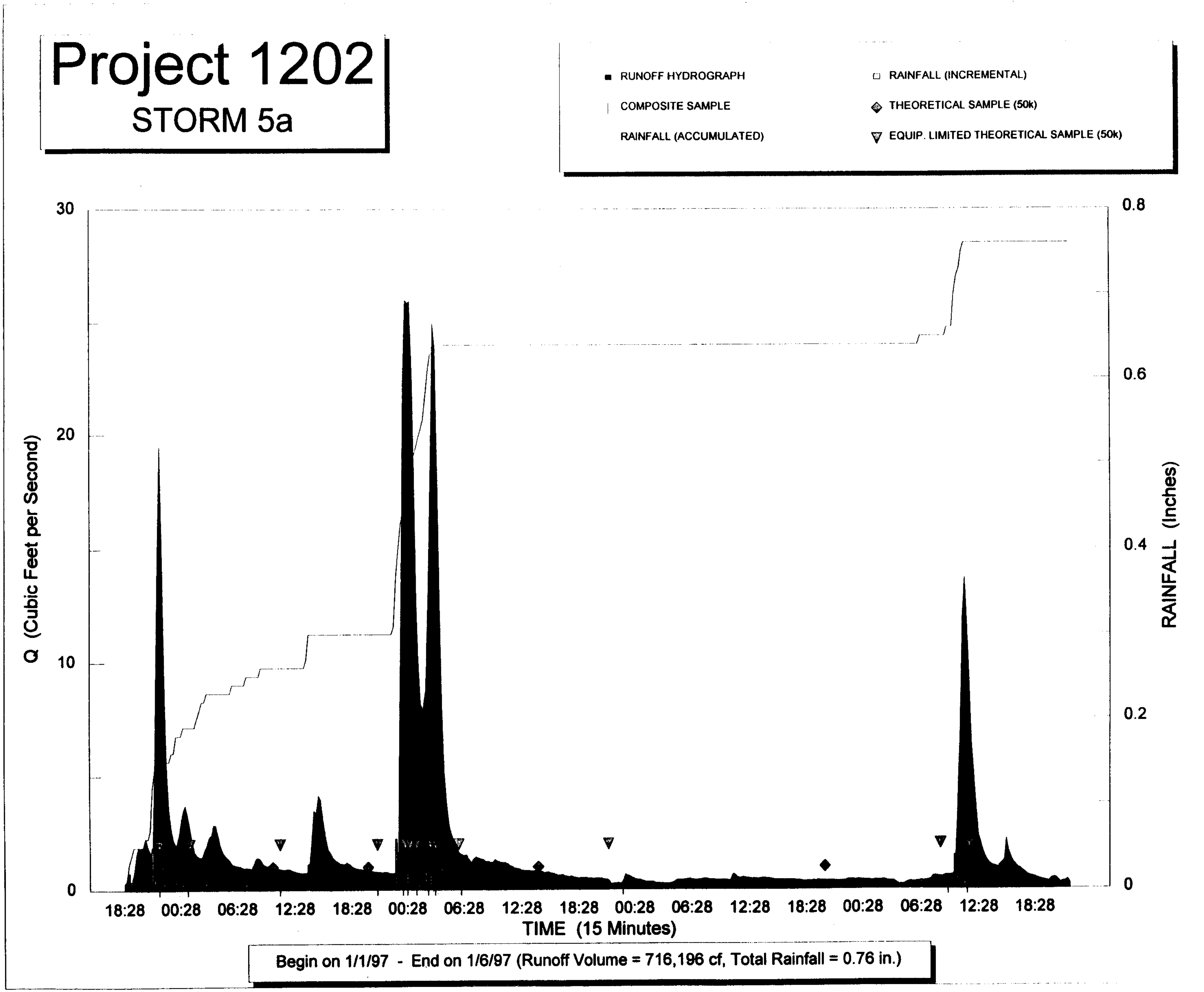
Project 1202
STORM 3
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
Q (Cubic Feet per Second)
250
200
150
100
50
0
RAINFALL (Inches)
5
4
3
2
1
0
11:18
17:18
23:22
05:22
11:22
17:22
23:22
05:22
11:22
17:25
23:25
05:25
11:25
TIME (15 Minutes)
Begin on 12/09/96 - End on 12/12/96 (Runoff Volume = 5,204,750 cf, Total Rainfall = 4.25 in.)



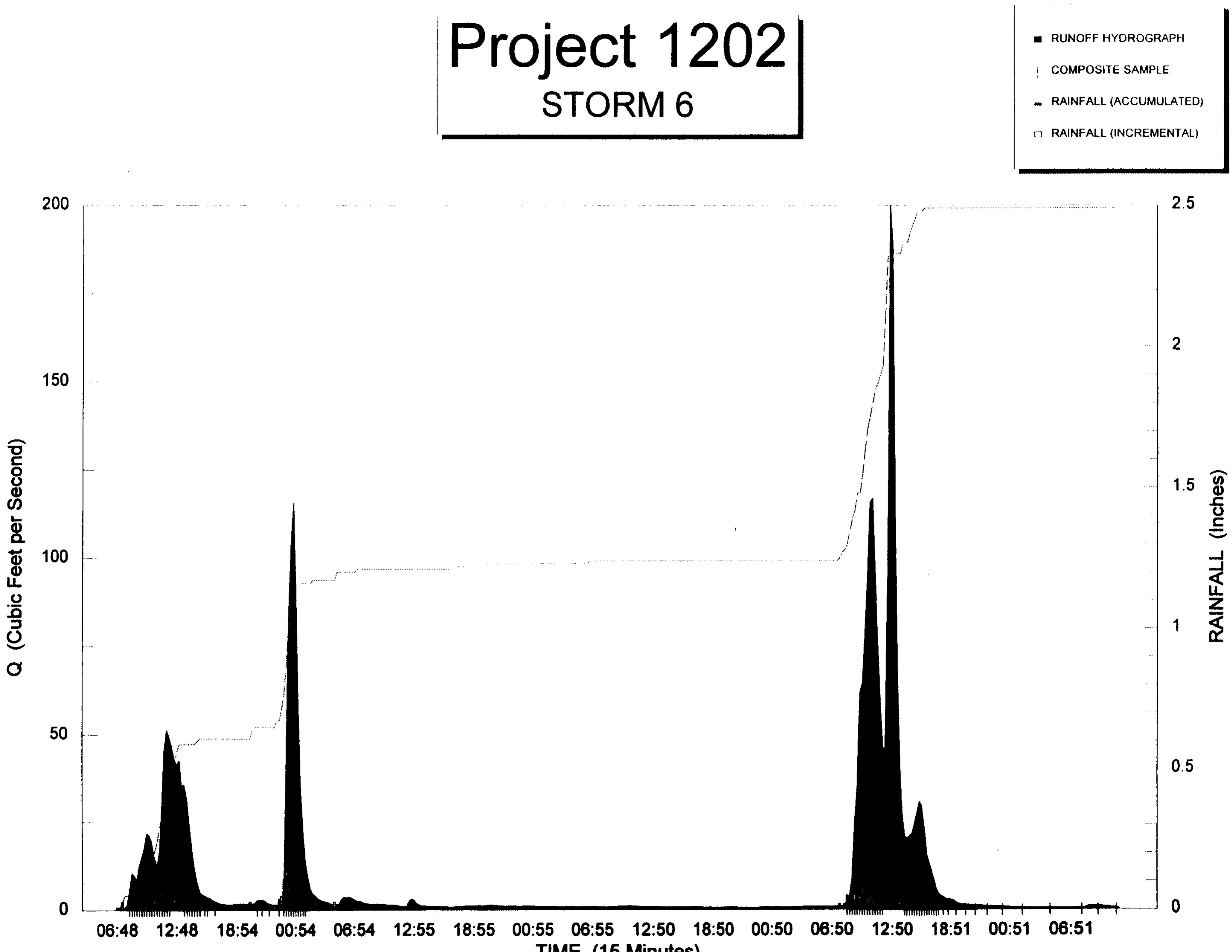
Project 1202
STORM 4
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
Q (Cubic Feet per Second)
14
12
10
8
6
4
2
0
RAINFALL (Inches)
0.2
0.15
0.1
0.05
0
05:44
07:14
08:44
10:14
11:44
13:14
14:44
16:14
17:44
19:14
20:44
22:14
23:44
01:14
02:44
TIME (15 Minutes)
Begin on 12/22/96 - End on 12/22/96 (Runoff Volume = 59,693 cf, Total Rainfall = 0.15 in.)



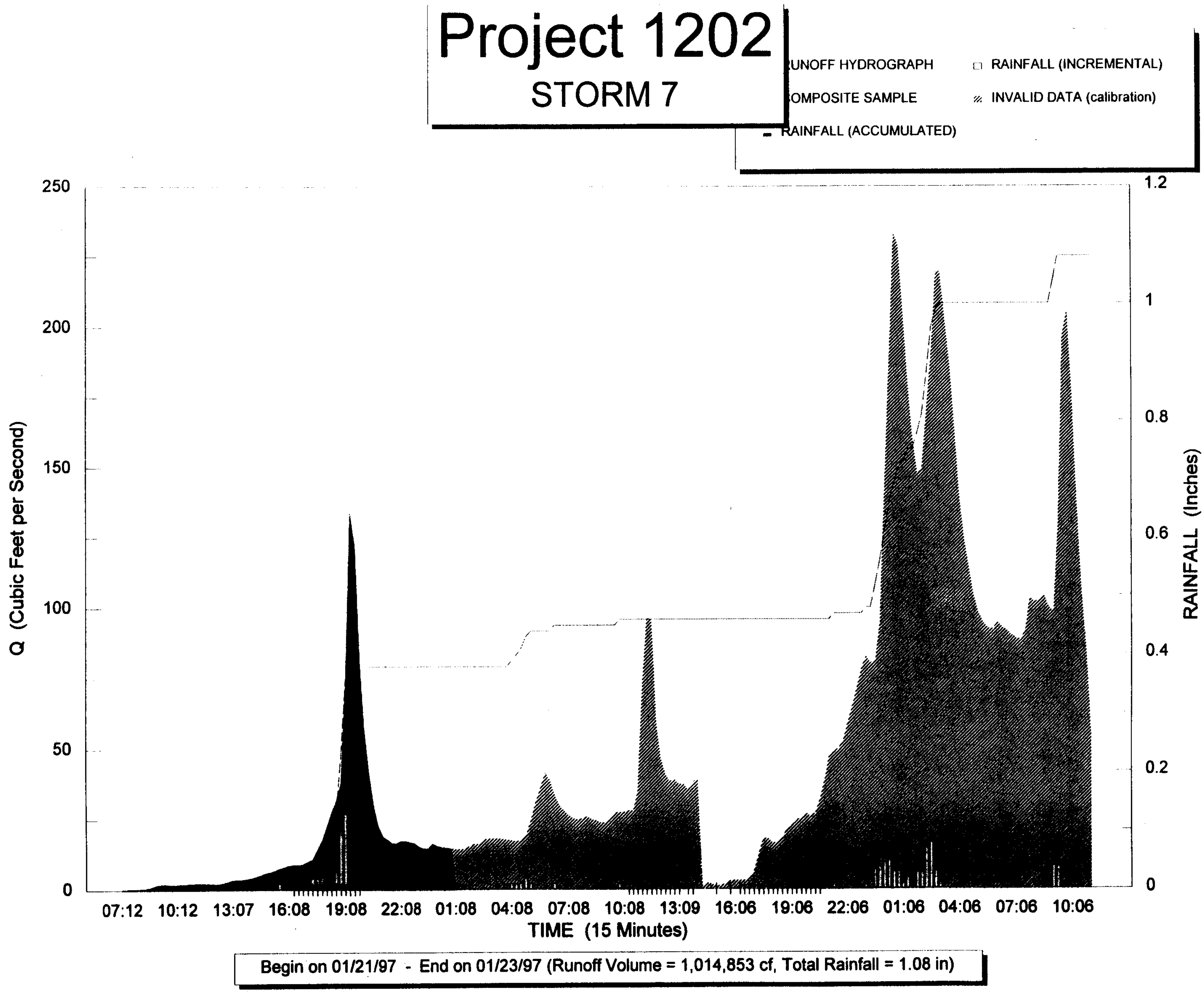
Project 1202
STORM 5
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
Q (Cubic Feet per Second)
60
40
20
0
RAINFALL (Inches)
1
0.5
0
01:27
02:57
04:27
05:57
07:27
08:57
10:27
11:57
13:27
14:54
16:24
17:46
19:16
20:46
TIME (15 Minutes)
Begin on 12/27/96 - End on 12/27/96 (Runoff Volume = 1,052,871 cf, Total Rainfall = 0.84 in.)

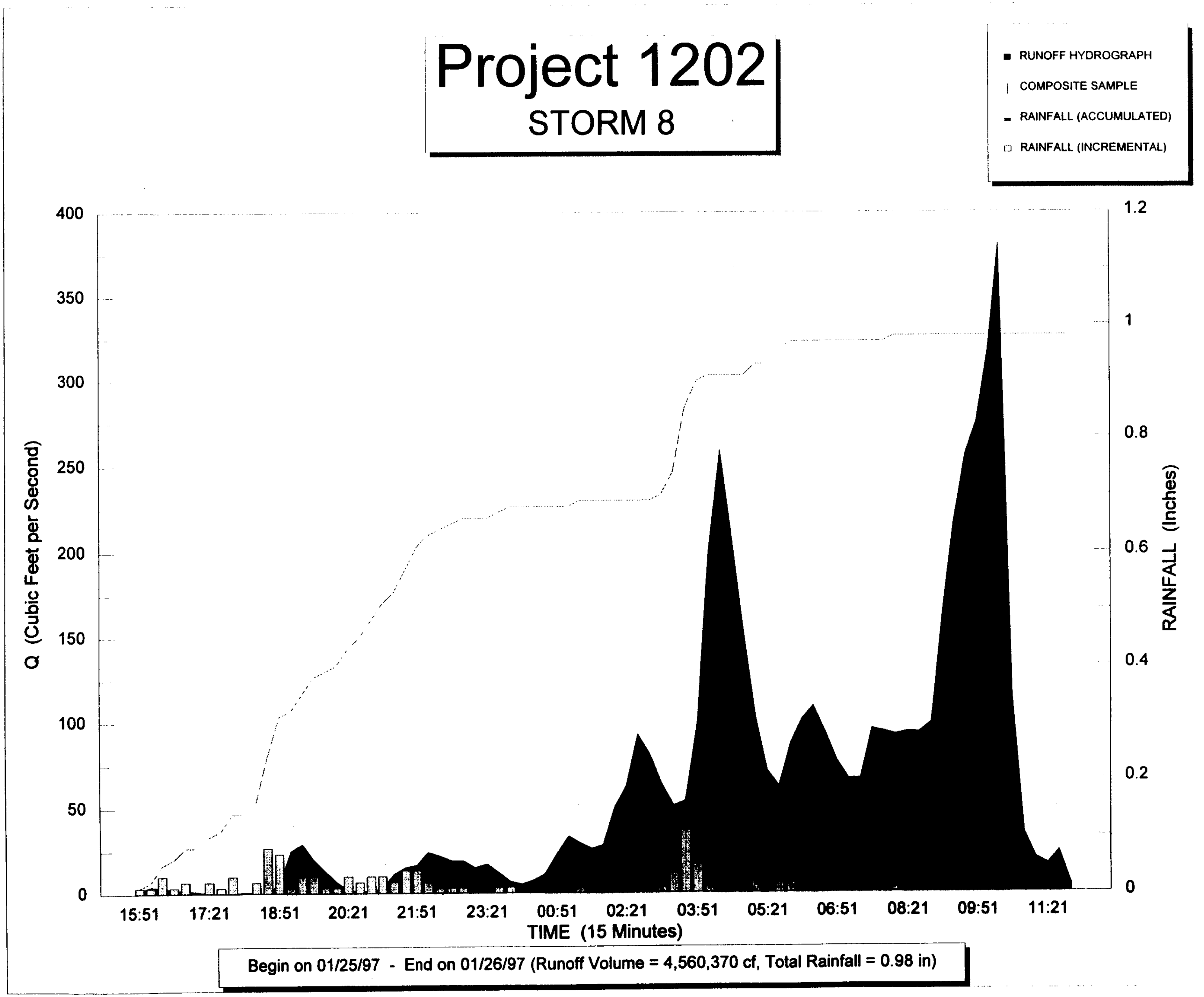

Project 1202
STORM 5a
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
THEORETICAL SAMPLE (50k)
EQUIP. LIMITED THEORETICAL SAMPLE (50k)
Q (Cubic Feet per Second)
RAINFALL (Inches)
30
20
10
0
0.8
0.6
0.4
0.2
0
18:28
00:28
06:28
12:28
18:28
00:28
06:28
12:28
18:28
00:28
06:28
12:28
18:28
00:28
06:28
12:28
18:28
TIME (15 Minutes)
Begin on 1/1/97 - End on 1/6/97 (Runoff Volume = 716,196 cf, Total Rainfall = 0.76 in.)

Project 1202
STORM 6

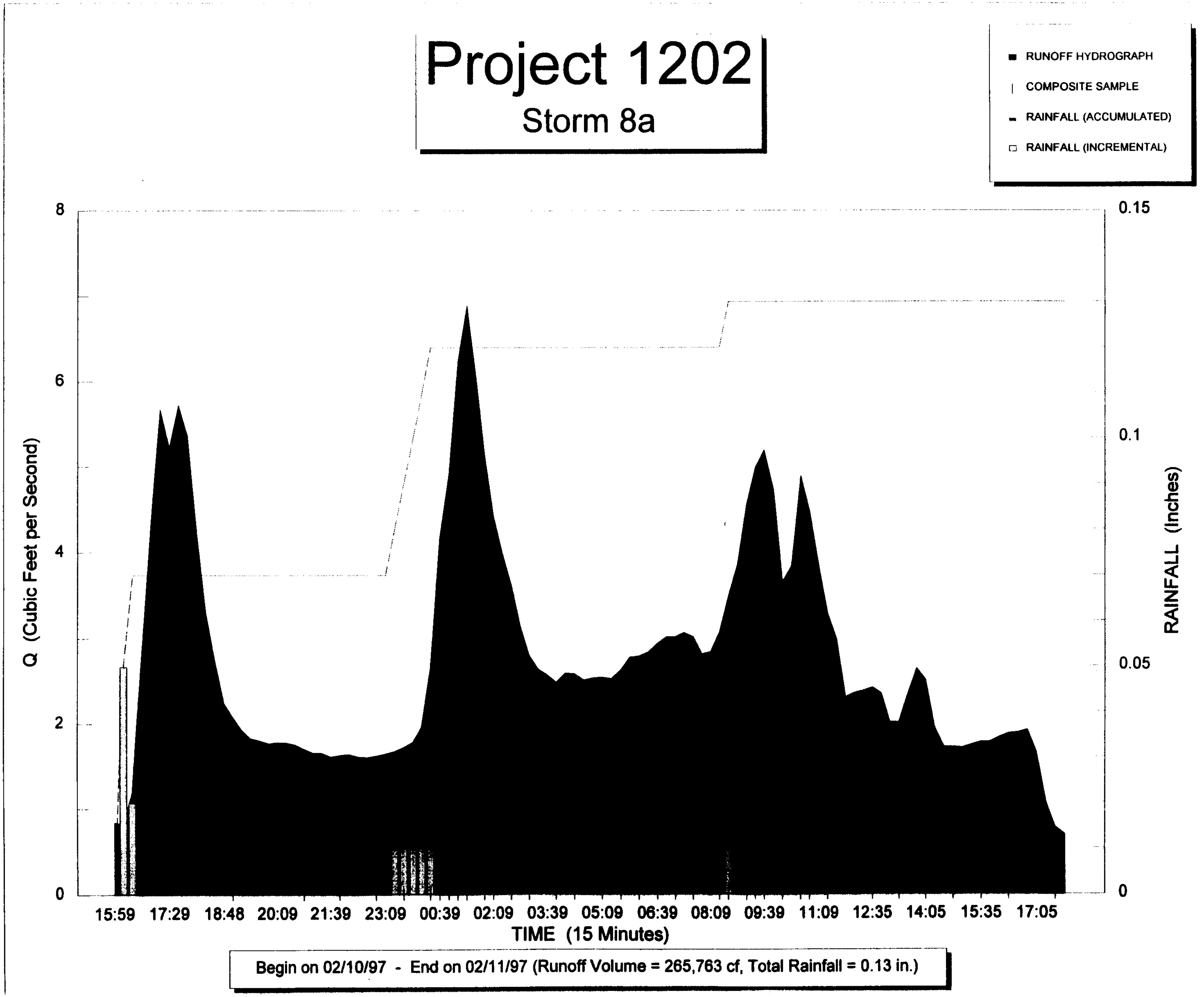


Begin on 01/12/97 - End on 01/16/97 (Runoff Volume = 3,255,836 cf, Total Rainfall = 2.49 in.)


Project 1202
STORM 7
RUNOFF HYDROGRAPH
RAINFALL (INCREMENTAL)
COMPOSITE SAMPLE
INVALID DATA (calibration)
RAINFALL (ACCUMULATED)
Q (Cubic Feet per Second)
RAINFALL (Inches)
250
200
150
100
50
0
1.2
1
0.8
0.6
0.4
0.2
0
07:12
10:12
13:07
16:08
19:08
22:08
01:08
04:08
07:08
10:08
13:09
16:06
19:06
22:06
01:06
04:06
07:06
10:06
TIME (15 Minutes)
Begin on 01/21/97 - End on 01/23/97 (Runoff Volume = 1,014,853 cf, Total Rainfall = 1.08 in)



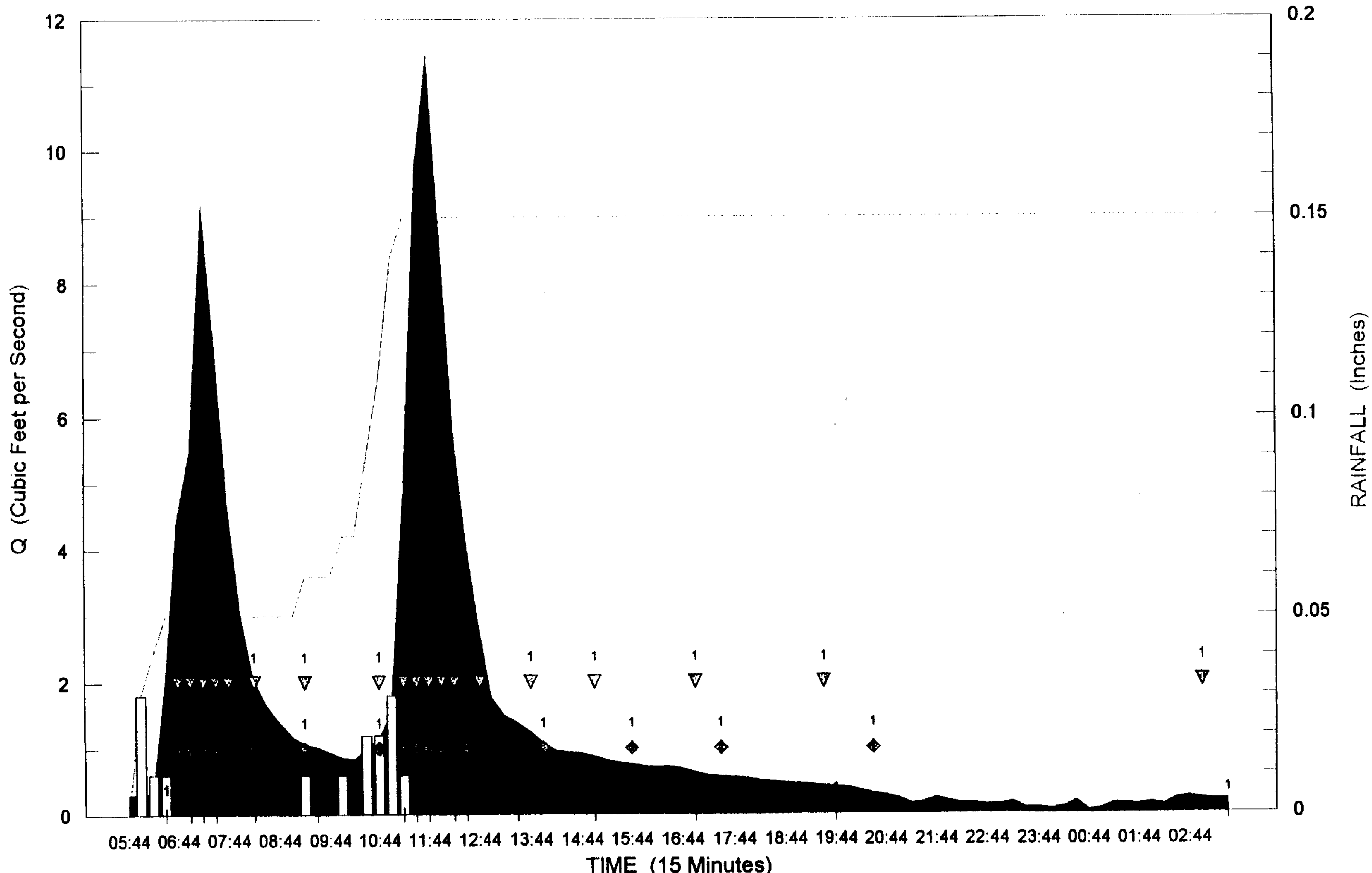
Project 1202
STORM 8
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
Q (Cubic Feet per Second)
400
350
300
250
200
150
100
50
0
RAINFALL (Inches)
1.2
1
0.8
0.6
0.4
0.2
0
15:51
17:21
18:51
20:21
21:51
23:21
00:51
02:21
03:51
05:21
06:51
08:21
09:51
11:21
TIME (15 Minutes)
Begin on 01/25/97 - End on 01/26/97 (Runoff Volume = 4,560,370 cf, Total Rainfall = 0.98 in)



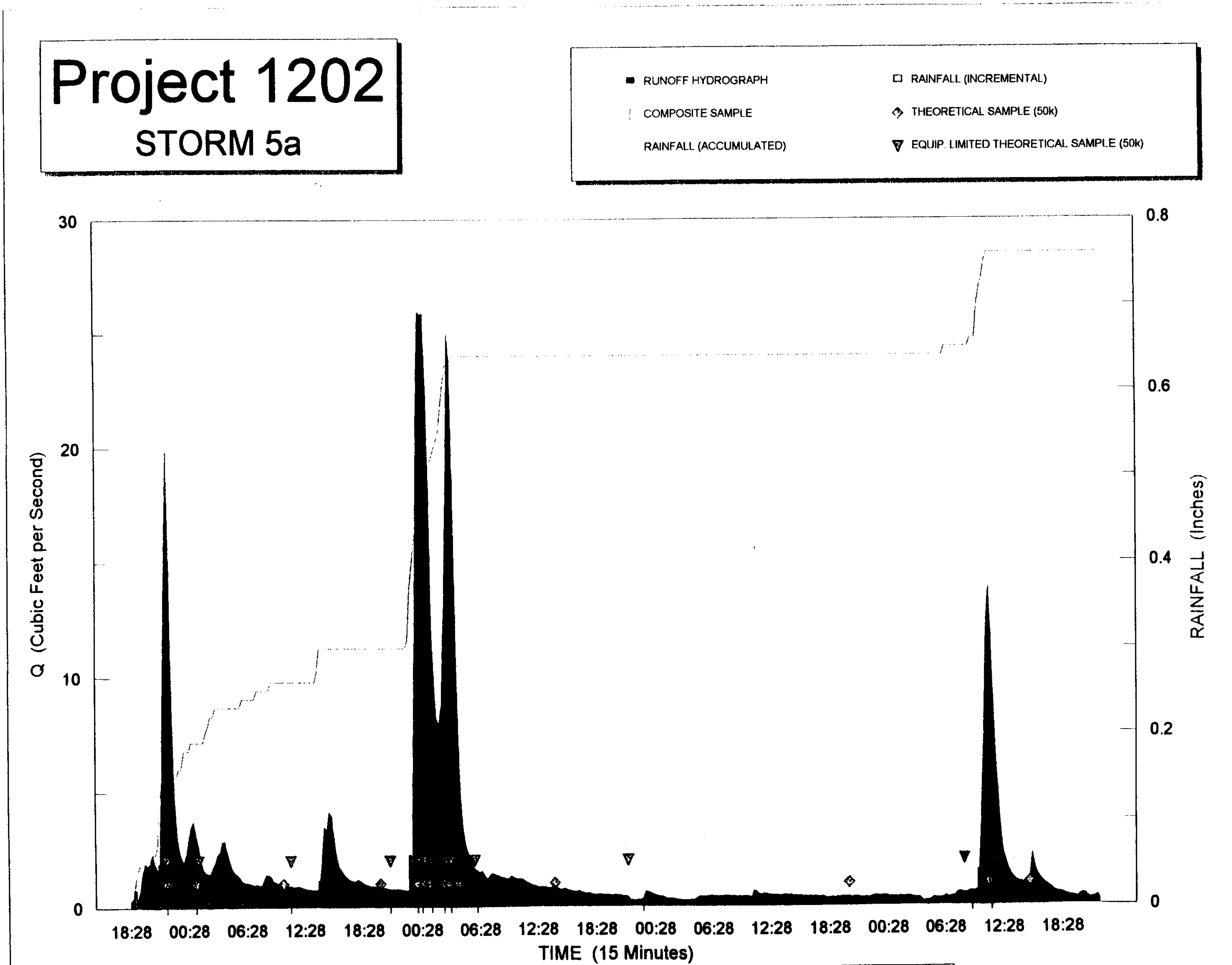
Project 1202
Storm 8a
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
Q (Cubic Feet per Second)
RAINFALL (Inches)
0
2
4
6
8
0
0.05
0.1
0.15
15:59
17:29
18:48
20:09
21:39
23:09
00:39
02:09
03:39
05:09
06:39
08:09
09:39
11:09
12:35
14:05
15:35
17:05
TIME (15 Minutes)
Begin on 02/10/97 - End on 02/11/97 (Runoff Volume = 265,763 cf, Total Rainfall = 0.13 in.)

ATTACHMENT D-2

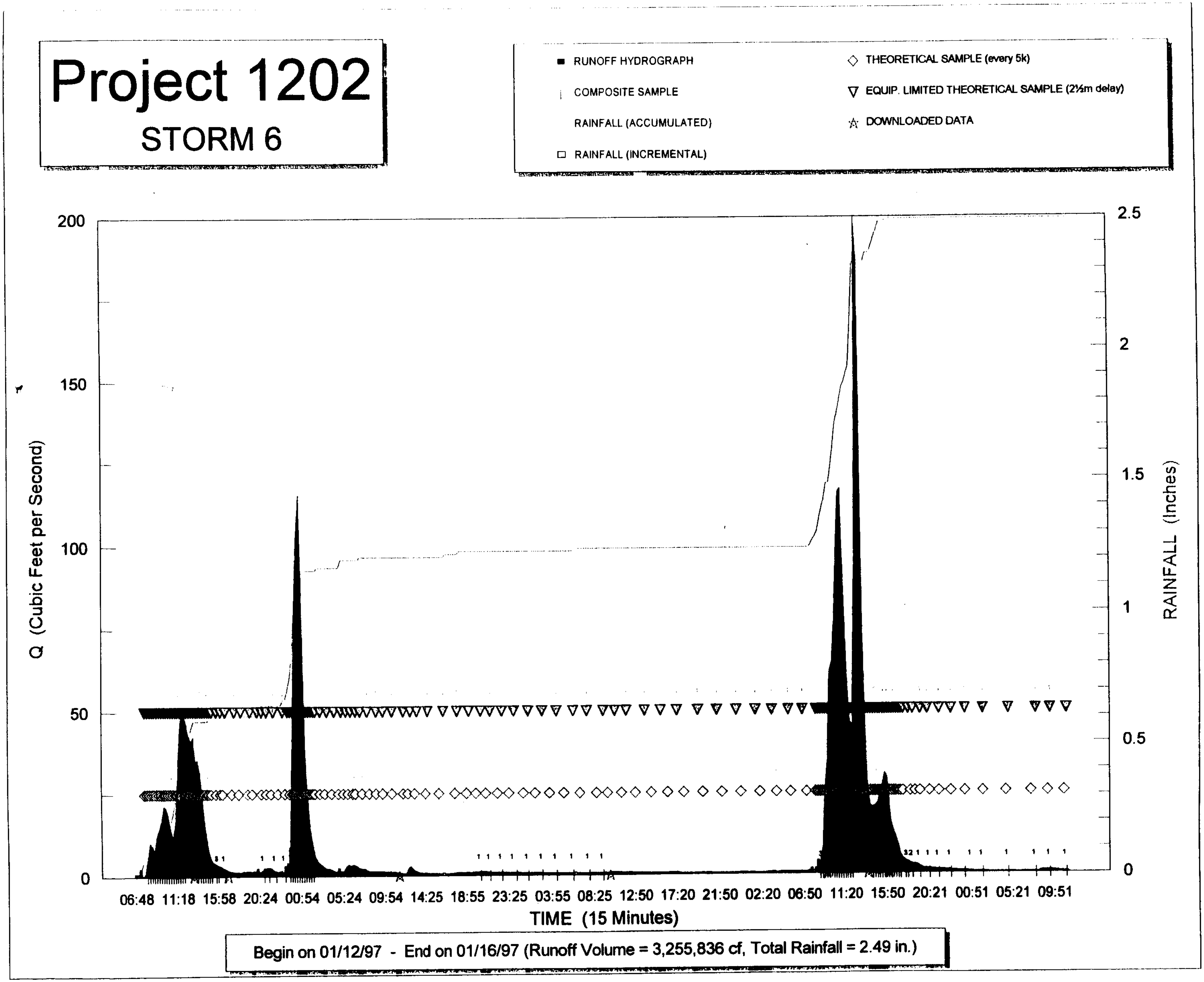
Project 1202
STORM 4



Begin on 12/22/96 - End on 12/22/96 (Runoff Volume = 59,693 cf, Total Rainfall = 0.15 in.)



Begin on 1/1/97 - End on 1/6/97 (Runoff Volume = 716,196 cf, Total Rainfall = 0.76 in.)



Project 1202
STORM 6
RUNOFF HYDROGRAPH
COMPOSITE SAMPLE
RAINFALL (ACCUMULATED)
RAINFALL (INCREMENTAL)
THEORETICAL SAMPLE (every 5k)
EQUIP. LIMITED THEORETICAL SAMPLE (2½m delay)
DOWNLOADED DATA
Q (Cubic Feet per Second)
200
150
100
50
0
RAINFALL (Inches)
2.5
2
1.5
1
0.5
0
06:48 11:18 15:58 20:24 00:54 05:24 09:54 14:25 18:55 23:25 03:55 08:25 12:50 17:20 21:50 02:20 06:50 11:20 15:50 20:21 00:51 05:21 09:51
TIME (15 Minutes)
Begin on 01/12/97 - End on 01/16/97 (Runoff Volume = 3,255,836 cf, Total Rainfall = 2.49 in.)